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TECHNICAL DISCUSSION
ATTACHMENT IV
ELFIN FIELD TEST PROGRAM

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1. INTRODUCTION

This proposal is for a program which is a logical continuation of the present Elfin program. The present program is for the development of electrolytic techniques for measuring low energy microwave fields by the use of an antenna and diode to provide a current to be integrated by an electrolytic cell. The proposed program is for field and laboratory testing of these devices to demonstrate their sensitivity, dynamic range, and frequency discrimination ability.

The present research and development program has attained significant success insofar as it has produced electrolytic cells of sensitivity beyond that which was initially proposed. The present electrolytic cells are capable of integrating quantities of charge as small as 10 millimicrocoulombs and allowing readout of this quantity of charge in a time interval of 10 seconds with an accuracy of a few percent. The proposed continuation of this program will result in the taking of the Elfin devices composed of the electrolytic cell, diode, and antenna to the vicinity of various radars, exposing the antennas to the radars for fixed intervals of time, analyzing the results and comparing with predicted results. Additional work will be continued in the laboratory to improve the devices on the basis of the field tests and to devise new devices capitalizing on the sensitivity of the electrolytic cells which have been developed.

2. STATUS REPORT ON PRESENT STUDY

The review of the progress reports on the present study will indicate that considerable progress has been made since the initiation of this study in the integration of very small currents. It was found, as anticipated, that considerable care is necessary in the preparation of the cells to insure maximum cleanliness. Indeed, numerous rinsings with distilled water are necessary after the cells have been cleaned with various acids to remove traces of the acids from the cells. Of particular importance in the development of high sensitivity cells is the manner in which electrodes are made and assembled in the cells. This one area has, perhaps, caused more difficulties than any other and the resolution of these difficulties has led

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to greater improvements in sensitivity than the development of any other area. It has been found important to keep the electrode area rather small for various reasons, thus 3 mil platinum wire is used in the assembly of the electrodes. Likewise, it was found that a very good match between the thermal coefficient of the wire and that of the glass is important to insure that the glass is sealed well to the wire to avoid crevices which can capture the electrolyte solution. The result is that cells are presently made out of soft glass which operate at readout currents as small as a millimicro ampere. In order to keep the impedance of the cell very low, it is necessary to assemble the electrodes in such a manner that they are only a few thousandths of an inch apart. The resulting cells are T-shaped and, being made of soft glass, have a certain degree of fragility. It is anticipated that in the field test program these cells can be properly imbedded in a plastic resin along with the antenna and diode in such a manner as to provide a fairly rugged unit.

3. FIELD TEST PROGRAM

The purpose of the field test program will be to demonstrate the sensitivity and dynamic range of the Elfin devices under carefully controlled field test conditions. A second goal of the program will be to simulate accurately operational use of the devices and to determine and provide solutions for various operational problems that may arise. The overall objective of the program will be to provide Elfin devices and operational procedures which can be put into practice without further development or testing.

In order to present a fair sample of data, simulating operational conditions, it will be necessary to perform measurements in the vicinity of several radars with several different terrain conditions. It is anticipated that the radars used will be L- and S-band air defense acquisition radars. However, traffic control radars at airports may also be used. Many problems have been noted which will contribute to errors in determining the radar power by the Elfin field measurements. In particular, the antenna pattern and its gain in the vertical direction may be such that integration of the energy at surface level will not lead to an accurate

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estimate of the integrated energy throughout the hemisphere. An additional problem might be the use of the Elfin device too close to the radar antenna yielding pulses of height sufficient to drive the diode into the linear region and out of the square-law region so that the relationship between incident radar energy and current through the electrolytic cell is not predictable. It will also be important to know whether or not the radar is actually radiating during the test conditions since radars are frequently shut down for repair or testing even through the antennas may appear to be operating.

Because of these problems and others, it will be necessary to assemble a fair assortment of equipment to accompany the engineers and the Elfin devices on the field test programs. It will also be more efficient to do the readout of the cells at the field test location in order that time is not lost in transportation from the site to the laboratory and back. This will allow several measurements to be made with a single cell comparing its reproducibility at given site locations from one series of measurements to the next. It is planned, therefore, to assemble equipments such as a radar receiver, cathode ray oscilloscope, microvolt ammeter, chart recorder, and others and mount these equipments in a small trailer which can be taken to the measurement site. It will be necessary, of course, to have the cooperation of the officers in charge of the site so that the collection of data will not result in any security difficulties.

Additional goals of the field test program will be to provide operational testing of more elaborate devices than the simple Elfin device which has been developed. In particular, it is intended to measure the frequency discrimination capability of a series of Elfin devices with different antennas or resonant circuits. Other devices using the basic Elfin principle under consideration are circuits for determining pulse width, PRF, and other characteristics of the radar signal. Of particular importance will be the development of techniques to measure antenna beamwidth and gain for rotating antennas.

A final phase of the field test program will include simulation of near operational conditions where one or two Elfin devices will be carried in the clothing of an engineer or technician and operated in the region of a particular radar. The actual experiment will be done by an individual

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not familiar in detail with the program but having received only simple instructions as to how to operate the equipment. On returning to the laboratory, the device will have the charge accumulated determined, and from this an estimate of the radar power will be made and compared to previous field measurements and knowledge of the radar system itself.

4. LABORATORY PROGRAM

In order to support the field test program, a certain amount of backup work in the laboratory will be necessary. It will be necessary to prepare the devices, check them out in the laboratory, and check them out upon return from the field test experiments.

Additional laboratory work will be done to continue the improvement of the electrolytic cell sensitivity since the limit of its capability has not yet been reached. Additional application of the cells and their enhanced sensitivity will be investigated along the lines of the application originally intended. To this end, one can almost specify an ideal Elint system for this kind of a device which will determine a number of radar parameters such as power, frequency, PRF, pulse width, polarization, antenna beam width and gain, the presence of simultaneous multiple frequency emissions, frequency jumping, variation in PRF, pulse compression, and scan period. If all, or a large number of these parameters could be determined in a device which required little or no power of its own, and could be packaged in very convenient form, a considerable advancement in electronic intelligence will have been made. Preliminary analysis indicates that such a goal is not beyond the realm of possibility.

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